Designation: C1403 – 22a

Standard Test Method for Rate of Water Absorption of Masonry Mortars[1]

This standard is issued under the fixed designation C1403; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method covers a standardized laboratory procedure for determining the relative water absorption by capillary uptake (wicking) characteristics of masonry mortars. This test method is not applicable for determining the effectiveness of water repellent coatings.

1.2 The text of this standard refers to notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3.1 Inch-pound units are given in parentheses for temperature specification and are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens)

C230/C230M Specification for Flow Table for Use in Tests of Hydraulic Cement

C270 Specification for Mortar for Unit Masonry

C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C778 Specification for Standard Sand

C1180 Terminology of Mortar and Grout for Unit Masonry

C1384 Specification for Admixtures for Masonry Mortars

C1437 Test Method for Flow of Hydraulic Cement Mortar

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology C1180.

4. Significance and Use

4.1 This test method provides a laboratory procedure for determining the relative water absorption properties over time of mortars used for masonry construction. Because the specimens are made under laboratory conditions and do not take into account the effect of the masonry substrate or field mixing procedures, this method is not intended for field use. Data generated from this test method may be useful for determining the relative effectiveness of water repellent admixtures or the effect of other admixtures or mortar components on the water repellency of a mortar. However, use caution in interpreting the results. While the resistance of masonry to water penetration may be related to the water absorption of the mortar, it also depends on other factors, such as the workmanship, extent of bond, and the properties of the masonry units and mortar.

NOTE 1—This test method is specified in Specification C1384 for demonstrating compliance of mortar admixtures classified as Water Repellent. In this compliance testing, the admixed mortar is compared to a reference mortar made with the same mortar materials except that it does not include the admixture. For quality control testing of water repellent preblended dry mortar mixes, the reference mortar is not typically available since the water repellent additive is added during the manufacturing process prior to bagging the final product. In these cases, the procedure in Annex A1 can be used to determine the relative resistance of the mortar to absorption by capillary uptake.

5. Apparatus

5.1 *Balance*—A balance readable and accurate to 0.1 g.

[1] This test method is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.20 on Research for Mortars and Grouts.

Current edition approved Dec. 1, 2022. Published December 2022. Originally approved in 1999. Last previous edition approved in 2022 as C1403 – 22. DOI: 10.1520/C1403-22A.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

5.2 *Uptake Container*—A watertight container with a minimum cross sectional area that is at least 50 % greater than the total area of the specimens' test surface(s) and a minimum depth of 75 mm. Provide a cover for the container to minimize evaporation.

5.2.1 Use specimen supports that allow a minimum of 3 mm clearance from the bottom of the container and that cover no more than 10 % of the area of the specimen's test surface. Use supports made of a material that does not float in water and that does not rust, expand, or contract as a result of water exposure.

5.2.2 The container shall be flat so that when a specimen is set on the supports the water level as specified in 7.4 shall not vary by more than 1 mm from one end of the specimen to the opposite end.

5.3 *Specimen Molds*—Metal nominal 50-mm cube specimen molds with removable plastic water tight disposable liners. The plastic liners shall be rigid enough to retain their shape when free standing and filled with mortar.

NOTE 2—For this test method, actual specimen dimensions are measured and used to calculate absorption per a unit area; therefore, 2-in. cube specimen molds can be used interchangeably with 50-mm cube specimen molds.

5.4 *Mixer, Bowl, and Paddle*—An electrically-driven mechanical mixer of the type equipped with paddle and mixing bowl, as specified in Practice C305.

5.5 *Flow Table and Flow Mold,* conforming to the requirements of Specification C230/C230M.

5.6 *Tamper and Trowel,* conforming to the requirements of Test Method C109/C109M.

5.7 *Moist Cabinet or Room,* conforming to the requirements of Specification C511.

5.8 *Oven*—A ventilated oven of appropriate size capable of maintaining a uniform temperature of 110 ± 5°C (230 ± 9°F).

5.9 *Timing Device*—A timing device readable and accurate to 1 s.

5.10 *Calipers*—Suitable calipers with parallel jaws for measuring the dimensions of the hardened specimens to the nearest 0.1 mm.

6. Specimen Preparation

6.1 Prepare mortar according to Practice C305, adjusting the water as necessary to obtain a flow of 110 ± 5 as determined by Test Method C1437. Record the flow. If an admixture is being added to the mortar, the dosage rate, time of addition, and mixing sequence shall follow the manufacturer's recommendation. If there is no manufacturer's recommendation, add a liquid admixture with the water and add a dry admixture with the cementitious components. Record the type and amount of each material by weight used in the mortar. In addition, record the type and amount by weight or volume of any admixture used and when it was added to the mix. If applicable, record the kind of mortar (cement-lime, mortar cement, or masonry cement), the type (O, N, S, or M), and whether the mortar is made to the proportion or property specification of Specification C270.

6.1.1 To test the behavior of mortar components independent of the qualities of the masonry sand use a blend of equal parts by weight of graded standard sand and standard 20 - 30 sand conforming to Specification C778.

6.2 Prepare 50-mm cube specimens according to Test Method C109/C109M except the mortar shall be the mortar prepared in 6.1 and the molds shall be as specified in 5.3. Make a minimum of three replicate specimens from each mortar batch.

6.3 Immediately upon completion of casting, place the test specimens in a moist closet or moist room conforming to the requirements of Specification C511. Keep all test specimens in their molds and in the moist closet or moist room for 24 ± 1 h with their upper surfaces exposed to the moist air but protected from dripping water.

6.4 At 24 ± 1 h from the time of mixing remove the specimens from the molds. Mark the side of each specimen indicating which surface is top, as cast. Cure the specimens in a moisture tight plastic bag at 24 ± 8°C (75 ± 15°F) until placing in the oven in accordance with 6.5.

6.5 Unless another age is specified, at the age of 28 days ± 12 h from the time of casting, remove the specimens from the plastic bag and dry in a ventilated oven at 110 ± 5°C (230 ± 9°F) for not less than 24 h and until two successive weighings at intervals of 2 h show an increment of loss not greater than 0.2 % of the last previously determined weight of the specimen. Remove the specimens from the oven and cool in ambient conditions (24 ± 8°C (75 ± 15°F)) and a relative humidity of less than 80 % for a minimum of 2 h and until the specimens reach ambient temperature. Begin testing within 24 h after reaching ambient temperature.

7. Procedure

7.1 Calculate the area of the test surface for each specimen from the length and width of the test surface. The test surface is the top face of the cube, as cast. Using calipers, measure the length of the cube test surface to the nearest 0.1 mm at three locations along its height and record as L_1 the average length in millimetres to the nearest 0.1 mm. Using calipers, measure the width of the cube test surface to the nearest 0.1 mm at three locations along its height and record as L_2 the average width in millimetres to the nearest 0.1 mm.

7.2 Record as W_0 the initial weight in grams to the nearest 0.1 g of each individual specimen immediately prior to testing.

7.3 Place the uptake container on a flat level surface. Place all specimens in the uptake container(s) with their top faces, as cast, in contact with the specimen supports as illustrated in Fig. 1. Provide a minimum space of 12 mm between specimens and 25 mm between specimens and the wall of the uptake container.

7.4 Add room temperature (24 ± 8°C (75 ± 15°F) water to the uptake container(s) so that the specimens are partially immersed in 3.0 ± 0.5 mm of water. When adding water make sure not to splash water onto the specimens. Cover the uptake container(s) to minimize evaporation.

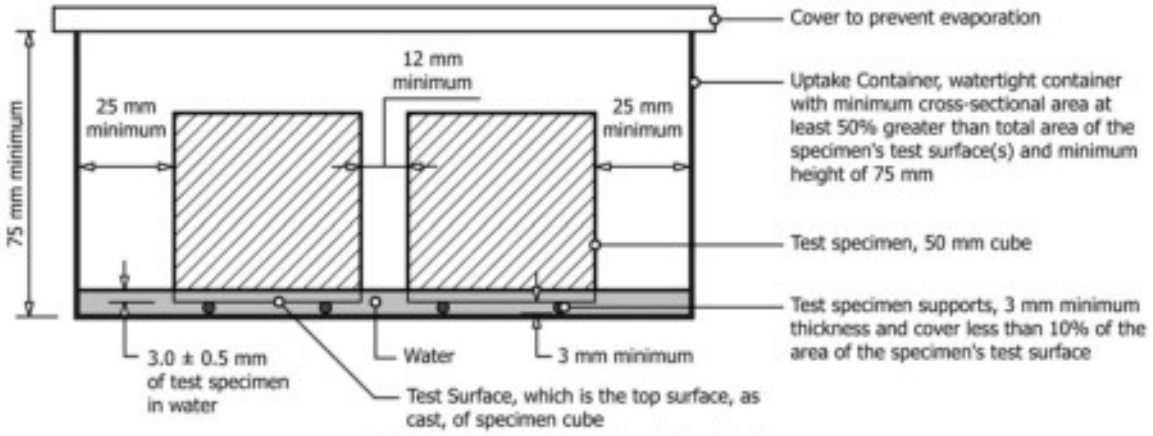

FIG. 1 Specimen Configuration During Testing

7.5 Monitor the specimens during the first 1 min and after 5 ± 1 min to make sure the water level is adequate during the initial absorption phase. Add water as necessary to maintain the immersion depth as specified in 7.4. When adding water make sure not to splash water onto the specimens. Cover the uptake container(s) to minimize evaporation.

7.6 At 0.25 h ± 0.5 min, 1 h ± 2 min, 4 h ± 10 min, and 24 h ± 15 min, measure the weight in grams to the nearest 0.1 g of each specimen and record as W_T, where T is the measurement time in hours. Wipe off surface water from each specimen with a damp cloth prior to each weighing (see Note 3). Complete the wipe within 10 s of removal from contact with the water and complete weighing within 1 minute.

NOTE 3—The wipe-off cloth should be damp enough so it does not wick water off the specimen surface but not so damp that it is dripping water. Experience has shown that the cloth may need to be wrung out every 8 to 12 cubes to keep it from getting too wet.

7.7 After each weighing, replace the specimens into the uptake container(s) and add water as necessary to maintain the immersion depth specified in 7.4. When adding water, make sure not to splash water onto the specimens. Re-cover the uptake container(s).

8. Calculation

8.1 Calculate and record as A_T the water absorption in grams/100 cm^2, at each time period, T, for each specimen, as follows:

$$A_T = (W_T - W_0) \times 10\,000/(L_1 \times L_2) \quad (1)$$

where:

W_T = the weight of the specimen at time T in grams to the nearest 0.1 g,
W_0 = the initial weight of the specimen in grams to the nearest 0.1 g,
L_1 = the average length of the test surface of the mortar specimen cube in mm to the nearest 0.1 mm, and
L_2 = the average width of the test surface of the mortar specimen cube in mm to the nearest 0.1 mm.

8.2 Calculate and record as, A_T (avg), the average A_T for each set of three or more replicate specimens at each time interval.

9. Report

9.1 Report the mortar mixture, as follows:

9.1.1 The type and amount of each material by weight used in the mortar,

9.1.2 The type and amount by weight or volume of any admixture used in the mortar and when it was added to the mix,

9.1.3 The actual flow of the mortar batch(es), and

9.1.4 If applicable:

9.1.4.1 The kind of mortar (cement-lime, mortar cement, or masonry cement),

9.1.4.2 The type (O, N, S, or M) used, and

9.1.4.3 Whether the mortar was made to the proportion or property specification of Specification C270.

9.2 Report the water absorption test results, as follows:

9.2.1 For each specimen, report:

9.2.1.1 L_1, the average length of the test surface of the mortar specimen cube in mm to the nearest 0.1 mm,

9.2.1.2 L_2, the average width of the test surface of the mortar specimen cube in mm to the nearest 0.1 mm,

9.2.1.3 W_0, the initial weight of the specimen in g to the nearest 0.1 g,

9.2.1.4 W_T, the weight of the specimen at each time T in g to the nearest 0.1 g, and

9.2.1.5 A_T, the water absorption of the specimen at each time T in g/100 cm^2.

9.2.2 For each set of three or more replicates, report:

9.2.2.1 A_T (avg), the average water absorption at each time T in g/100 cm^2.

9.3 Report the age of specimens when tested.

10. Precision and Bias

10.1 A precision and bias statement is not available for this test method.

11. Keywords

11.1 absorption; absorption rate; masonry mortar; water repellent

ANNEX

(Mandatory Information)

A1. TEST PROCEDURE FOR RELATIVE WATER ABSORPTION BY CAPILLARY UPTAKE OF MORTARS WHEN A REFERENCE MORTAR IS NOT AVAILABLE

A1.1 Scope

A1.1.1 This procedure can be used to determine the relative resistance of a mortar to absorption by capillary uptake (wicking) when a reference mortar is not available.

A1.2 Significance and Use

A1.2.1 In this procedure, the relative resistance of a mortar to absorption by capillary uptake is expressed as the amount of water absorption of the test specimen at any given test time versus the amount of water absorption of the test specimen at full saturation. This procedure can be used for quality control testing of water repellent preblended dry mortar mixes where the reference mortar is not typically available since the water repellent additive is added during the manufacturing process prior to bagging the final product.

NOTE A1.1—Mortars without water repellent additives generally achieve 95 to 100 % of total saturation in 24 hours. When testing water repellent preblended mortars, it is difficult or impossible to obtain reference mortar material (no additive included) because the water repellent is added during manufacturing. But the total saturation value of a water repellent mortar (A_S) will approximate the 24-h water absorption of its reference mortar (A_{24}), if that were available. By testing the water repellent containing mortar for total saturation and substituting that for the 24-h water absorption value of a (not available) reference mortar, one can approximate the effect of the admixture on reducing water absorption.

NOTE A1.2—While the results from this testing (% A_T) are related to the results (Water Repellent Mortar A_T / Reference Mortar A_T) used for compliance of mortar admixtures that meet the Water Repellent Classification of Specification C1384, they do not represent identical properties. Therefore, the results of this testing (%A_T) should not be used to determine compliance with the Rate of Water Absorption requirements in Specification C1384 for mortar admixtures classified as Water Repellent.

A1.3 Apparatus

A1.3.1 *Absorption Tank*—A watertight tank suitable for determining total absorption. The tank shall be of sufficient size to contain the specimens and maintain the required spacing and water level as required in A1.4.1.

NOTE A1.3—A 20-L or 5-gal pail with a piece cut from a fluorescent light diffuser grid with nominal 12-mm grid openings works well as an absorption tank with a support system that has adequate open area.

A1.4 Procedure

A1.4.1 Follow the procedure described in Section 7 with these additional steps:

A1.4.1.1 Immediately after the final weighing of the test specimen at 24 hours in accordance with 7.6, fully submerge the specimen in the absorption tank containing water at a temperature of 24 ± 8°C (75 ± 15°F) such that the top surface of the specimen is at least 150 mm below the surface of the water. Specimens shall be separated from each other and from the bottom of the immersion tank by at least 3 mm, using wire mesh, grating, or other spacers so that not more than 10 % of the surface area of the specimen is in contact with the spacer.

A1.4.1.2 After 24 ± 0.5 h hours in the absorption tank, remove each specimen from the water, wipe off visible surface water with a damp cloth, weigh and record the saturated weight as W_S to the nearest 0.1g. Complete the wipe within 10 seconds of removal from contact with the water and complete weighing within 1 minute.

A1.5 Calculations

A1.5.1 For all specimens, calculate the following for each specimen and as an average for the set of three specimens:

A1.5.1.1 The water absorption of the specimen at each time T in g/100 cm^2, A_T, in accordance with 8.1.

A1.5.1.2 The water absorption at total saturation, A_S, as follows:

$$A_S,\ \text{g/100 cm}^2 = [10\,000 \times (W_S - W_o)] / [L_1 \times L_2] \quad \text{(A1.1)}$$

A1.5.1.3 Relative water absorption, $\%A_T$, in percent of total saturation at each time T as follows:

$$\%A_T = (A_T / A_S) \times 100\% \quad \text{(A1.2)}$$

A1.6 Report

A1.6.1 Test reports shall include all of the information in 9.2 and the following:

A1.6.1.1 A_S, the water absorption at total saturation to the nearest 0.1 g/100 cm^2 for each specimen and as an average for the set of three or more replicates.

A1.6.1.2 $\%A_T$, the relative water absorption in percent of total saturation at each time T to the nearest 0.1 % for each specimen and as an average for the set of three or more replicates.

SUMMARY OF CHANGES

Committee C12 has identified the location of selected changes to this standard since the last issue (C1403 – 22) that may impact the use of this standard. (December 1, 2022)

(1) Added 1.2 on non-mandatory notes and footnotes (excluding those in tables and figures).

(2) Modified 5.9 to require the timing device to be readable and accurate to the nearest 1 s.

Committee C12 has identified the location of selected changes to this standard since the last issue (C1403 – 15) that may impact the use of this standard. (August 1, 2022)

(1) Modified 5.4 to 5.8 to make apparatus list consistent with that required to perform this test.
(2) Modified 5.10, 7.1, 8.1, and 9.2.1 to require the calipers and the reported measurements to be accurate to the nearest 0.1 mm.